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PROCEDURES IN WILDLIFE FOOD STUDIES[1/]

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Introduction

A knowledge of wildlife foods is properly recognized as fundamental to effective wildlife management. It reveals not only the vital dependence of particular kinds of wildlife upon certain plants and animals in their environment, but also provides factual data on predator-prey relationships and on the beneficial or obnoxious roles of various species in relation to man and his crops. Once the foods upon which wild animals subsist are known, the environment can be altered more intelligently to control wildlife populations.

This leaflet has been prepared in response to the numerous requests for information on suitable procedures in wildlife food studies.

The Fish and Wildlife Service is no longer engaged in extensive wildlife food-habits studies and is not in a position to accept miscellaneous serviceof specimens for analysis. Since 1942, the Service's activity in this field has been confined largely to sharing the use of its reference collections and other facilities with visiting investigators who come to the Patuxent Research Refuge, Laurel, Maryland, and Denver Wildlife Laboratory, Denver, Colorado. At these stations, professional guidance is provided by staff members experienced in food-habits work.

1/ This supersedes Leaflet 193, Directions for Collecting Materials for Food Habits Studies and Leaflet 222, Laboratory Procedures in Wildlife Food Studies.

General Principles

Procedure in food-habits studies is necessarily influenced by the objective. If the purpose is simply to learn the extent to which certain prey are taken or the quantities of certain farm crops, particular insects, or other special items consumed, then short-cuts can be taken and the task made comparatively simple. If, however, the aim is to piece together from many study units, a reliable composite indication of the kinds and extent of food-use of a wildlife species in a given locality or region under particular conditions of season and maturity, then the problem is much more involved. Further complexities appear if the purpose is to determine not merely food use but food preferences since this requires qualitative and quantitative appraisal of foods available in the habitat and comparisons of their abundance with actual consumption.

Procedures also must be adapted to the wildlife species concerned and to the kinds of study materials (stomachs, crops, droppings, pellets, etc.) that are available. Different food-habits methods and media are required for a study of the barred owl than for the wild turkey, the hummingbird, the moose, or the coyote.

Regardless of the major objective of the study, the wildlife species concerned, or the kinds of study media used, the following general principles apply:

(1) The sampling (of collected study media) should be extensive enough to provide a reliable foundation for conclusions. If the series examined is large, the inclusion of a few atypical specimens will not distort the results unduly.

(2) The sampling must be selective if there is to be adequate representation of the animal's feeding under significant time and space conditions. Deficiency in the quality and quantity of sampling tends to nullify the investment of time and care expended in subsequent steps. The importance of extensive and representative sampling accentuates the desirability of using all available kinds of study media and sources of information. Droppings, food caches, cheek pouches, debris at nests or roosts, and field observations on feeding may be valuable in completing dietary knowledge for seasons or localities inadequately represented by stomach specimens.

(3) The final results, even in well-planned, carefully conducted studies, generally should be regarded as giving only approximate indications of the actual feeding habits of the animal concerned. Numerous variables in the animals, their environment, the investigator and his methods, and in the degree to which partial digestion has altered original food proportions, make it inappropriate to view the data as exact and infallible. For this reason it is desirable to avoid the misleading implications of fractional percentages in results based on volumetric appraisals. Acknowledgment of approximateness in food-habits findings by no means minimizes the great value of this wildlife management tool. Nor does it justify undue carelessness in procedures. On the other hand, failure to recognize the natural limitations of habits data may, in itself, reduce the usefulness of the information.

Crops, gullets, or other study media that yield foods in undigested or only slightly digested condition are preferable to stomach contents, pellets, or droppings. Partially-digested foods are not only likely to have undergone substantial alteration of their original proportions but also are more difficult to identify and segregate. For this reason, recently developed techniques for removing crop or gullet contents without sacrificing the birds may be important.

Close correlation of its field and laboratory phases is a cardinal principle in food-habits work. Probably the best way to assure this is to have both aspects conducted by the same person. The investigator who collects the study specimens from the field has an opportunity to make observations on the feeding of the animal and on the identity and abundance of available food items. This field background can aid greatly in identifications and proper interpretations in the laboratory. In any event, there must be efficient coordination of information from field and laboratory or erroneous conclusions may result. Some food-habits studies consist entirely of field examinations but these projects are generally limited in scope and are not intended to culminate in a formal report.

Preliminary Handling of Materials

Labeling and recording

It is important that collection data be recorded at the time the materials are obtained. Postponement of this may result in the forgetting and omitting of some essential facts. Commonly information is recorded in a collector's record book as well as on good quality paper tags that can be tied to the stomachs, crops, or similar materials obtained. Labels of vulcanized fiber paper have been found to withstand preservatives for many years whereas on some common paper or cloth tags, the starchy covering dissolves leaving the recorded data illegible. The inscription must be clear and, in case materials are to be preserved, should be legible after immersion. A moderately hard lead pencil or carbon ink should be used to record all data that are placed in preservative solutions. The most important items usually recorded on tags are: animal's name; serial number; place; date; name of collector.

The sex and maturity of the animal may also be noted on the tag or details may be reserved for the notebook. Generally, an auxiliary notebook record of collection information proves useful.

If the entire digestive tract-- gizzard, intestine, and crop or gullet-- of a bird is to be saved for study it can be retained intact and, in accordance with common practice, the whole enclosed in a piece of cheesecloth with a single label attached. If crops, gullets, gizzards, or intestines are severed for separate study, care should be exercised to prevent loss of contents. Wrapping in cheesecloth or muslin helps to avoid such loss.

Droppings from birds and mammals and regurgitated pellets from owls and hawks may be collected as individual units or as lots that appear to represent particular time periods. Usually it is convenient to collect them in paper bags on which collection data can readily be inscribed. In all cases it is important that identification of the animal source be positive. Materials that are laid aside for future examination should be fumigated to destroy insects and should be further protected by napthalene flakes or similar chemicals placed in the container.

The stomach and other parts of the digestive tract of most mammals should be retained for study, though it is often advisable to remove the intestine if it does not contain food. It is usually impracticable to save the entire stomach contents of deer, elk, moose, or other large herbivorous mammals, but some notes on the extent of the actual or approximate quantity of material present may be desirable. About a quart of representative contents of the anterior stomach should be removed for examination-- either first mixing thoroughly the entire stomach contents or taking samplings from several parts of the food mass. Some of the large, more readily recognized pieces of food should be segregated to aid identification. If immediate analysis is intended, the sample should be washed thoroughly to remove digestive juices and then allowed to become partially dried. Otherwise, it may be immersed in a weak formaldehyde solution to prevent molding and stored, either wet or dry.

In the case of amphibians and reptiles, it is well to save the entire digestive tract or any parts of it containing food. If these animals cannot be accurately identified in the field, the entire specimen may be kept until determination of identity is completed.

Preservation

If stomach or crop materials collected for food-habits study are examined within 24 hours after acquisition, there usually is no need to use preservatives on them prior to analysis of contents. Ordinarily, however, it is more practical to make examinations at a later date.

The most reliable and economical preservative for stomachs and crops is a solution of formaldehyde, although alcohol (70 percent) may be used for small passerine birds. Medium-sized stomachs and crops should be placed in a solution made by diluting commercial formaldehyde with 24 parts of water. A stronger preservative is necessary for larger specimens and may be prepared with 12 to 15 parts of water. Large stomachs should be injected with the formaldehyde solution prior to being placed in it, or small slits may be cut in the walls to insure immediate penetration of the preservative. This precaution applies to stomachs of bears and other large mammals. Materials may be left in the preservative indefinitely. In removing material from formaldehyde solution, long forceps or rubber gloves should be used to protect the hands, as this preservative is irritating and tends to dry and shrivel the skin. Too much exposure of the eyes to the fumes may result in temporary harm to vision. Formaldehyde is a poison and should be treated as such.

If specimens preserved in formaldehyde are to be shipped from one point to another, the fluid should be drained off, leaving the materials moist. This makes shipping easier, helps to protect data on tags, and reduces the danger of leaking packages.

In general, it is advisable to retain examined materials for possible future re-examination until after a published report on the study has appeared and the public has had an opportunity to question the results.

Examination Procedures

Each food-habits study is unique in some degree, requiring a certain measure of individuality in methods employed. However, examinations of food materials, generally, have in common certain broad phases of procedure. These are: (1) preparation, (2) segregation, (3) identification (4) computation.

Preparation

The contents of stomachs and crops are usually washed in water preliminary to examination. This is particularly desirable when formaldehyde has been used as a preservative. Another advantage in washing is that it helps to remove the excessive mucous-like material that causes objects to adhere to each other. Ordinarily the stomach or crop contents are rinsed through sieves into shallow, white-enamel pans. Gravel and other heavy objects sink to the bottom and light, floating material can be decanted. Minute items that might otherwise be lost or not observed are collected by straining over a funnel covered with fine-mesh silk bolting cloth. The bolting cloth should first be wet with alcohol to facilitate rapid passage of water, otherwise, surface tension or clogging by grease may impede. Any residue left on the cloth is removed with a scalpel and placed on small squares of blotting paper. A partial segregation can be effected in conjunction with washing if each decantation of material is kept separate.

The stomach contents of predatory mammals usually require thorough washing with hot water, applied with pressure, to reduce or eliminate grease. For this work a moderately fine-meshed sieve or strainer is helpful. The washed contents are then squeezed to remove excess water and placed in a pasteboard box or on sheets of newspaper to dry. Occasionally it is readily evident that fatty materials dissolved by the hot-water treatment constitute a considerable proportion of the stomach contents. In such cases, a note as to the proportion and the identity of the material thus lost should be placed with the residue of contents, to aid the examiner in calculating percentages.

Not infrequently, when the food is mainly seeds-- as in the quail or doves or mammal cheek pouches-- washing is omitted, and the stomach or crop content examined "as is." This procedure, when feasible, saves considerable time. On opening the stomach, the character of its contents should decide whether it is to be examined dry, moist, or in a water bath. Sometimes certain items, such as soft-bodied insects, spiders, or crustaceans, should be kept wet until identified and the rest dried.

Dry droppings from birds can be crumbled for examination by breaking them in the fingers, or, if hard, by crushing under a hammer. Dry examination is easier and more rapid, but insect materials treated this way are less suitable for study than when the droppings have been soaked in water for some time.

Mammal droppings may be separated for examination by several methods. The simplest is to break them up by hand. If very hard, they can be soaked in water containing a small quantity of alcohol to prevent bacterial action. A third method is to wash the droppings through a series of graduated sieves or in a milk strainer-- using a stream of hot water with moderate pressure for the washing.

Pellets may be examined either wet or dry. Dry examination is the usual procedure, but the wet method is useful for fresh pellets, which are often heavily cemented with mucus. In the latter case the pellets are soaked an hour or two in a tray of water containing some alcohol until softened sufficiently to be easily separated. When examined dry, the pellets are simply pulled apart and the diagnostic structures separated from other material for identification and counting.

Segregation

In many cases segregation can and should be reasonably complete, but in others it is impracticable. In ruminants and rodents the items in stomach contents are generally so difficult to identify and so thoroughly mixed together that segregation is out of the question. To some degree, this is true of the stomach contents of other animals.

Segregation may be accomplished by various means, depending on the materials being sorted and, to some extent, on the equipment available. Sieves are particularly useful in making primary separations of different-sized materials. Among the more elementary means of segregation are floating and decanting, and the separation of dry objects of various sizes and shapes by shaking, rolling, or sliding on sheets of paper. Commonly, however, resort must be made to a slow, meticulous separation by forceps.

Identification

As previously noted, identification of items found in food-habits analyses can be facilitated by studying and collecting reference materials, plant or animal, at the time that stomachs, crops, or other study media are obtained. By constantly enlarging and improving their reference collections, institutions that are likely to participate repeatedly in wildlife food studies can make them very useful for local or regional investigations.

Accuracy is essential in all phases of food analyses and is particularly important in identification. Although specific determinations are often important in wildlife management, it is better to be correct in the genus than to make unjustified attempts at naming the species. Frequent comparisons should be made with reference materials instead of trusting memory too far. Materials that occur frequently or in quantity and that cannot be identified readily should be submitted to specialists for determination or confirmation.

In identifying worn or fragmented food items, it is generally expedient to start at the easiest point and progress to the more difficult. In herbivore stomachs, the larger, more-easily identified objects should be segregated first for determination. These larger items are usually represented among the more finely-divided materials. At the outset of a series of examinations, it is not advisable to spend much time trying to recognize puzzling items since their identity may be ascertained much more readily in subsequent study units.

Computation

As used here, computation refers to the statistics of food-habits studies; the actual data and the way in which they are obtained.

Since the early days of inquiry into wildlife foods, more than 65 years ago, there have been distinct schools of thought regarding the best method of expressing the results of these studies. Some stress the number of each kind of item eaten; some like frequency-of-occurrence data (the number of times an item appears in different individuals in a series); some are partial to figures that denote proportionate volumes (or mass) of each kind of item; and many use combinations of all three types.

Often the nature or objective of the investigation helps to determine the preferable statistical method. In predation studies there can be little doubt that numbers of the items eaten (3 rainbow trout, 1 bobwhite quail, 2 cottontails, etc.) are significant. When crop or gullet materials are available, there is a distinct advantage in denoting the proportionate quantities of different foods-- appraised either by estimates or measurement of mass (volume). On the other hand, in studies of stomachs, droppings, and pellets-- especially if predation is not a primary problem-- the issue of methods is not so clear cut and each investigator should decide the statistical course to follow. Substantial changes in proportions of food are commonly caused by digestion and volumetric figures are therefore not likely to give reliable indications of the amounts actually eaten. Because of this shortcoming, some students confine their statistical results to frequency-of-occurrence figures. This recourse also has its defects. For one thing, its statistically sound data have very limited significance in revealing the part which an item constitutes in the animal's diet. Also, in attempting to shield others from the possibility of being misled by volumetric data, the investigator withholds quantitative information which is usually of interest and value. A common alternative is to make both types of data available to the reader-- sometimes with numbers of each kind of item also listed.

Precise counting of items is feasible only when numbers are low. When they run above 50 or 100, rough estimates generally are used and "round number" figures denote this. A useful aid when dealing with large quantities of an item is to spread the material out evenly and after partitioning the whole into equal subdivisions, count the number in one of the small fractions and multiply. In instances of this sort, the total figure should, of course, be a "round" one.

Determining proportionate food quantities is accomplished in either of two ways; by visual estimates of relative proportions or by actual measurements of volume. The method used depends upon the nature of the materials encountered. Volumetric measurement is commonly undertaken in the case of items that are readily segregated and easily measured, whereas visual estimates of proportions are made a basis for percentage calculations when the objects eaten either are so small, mixed, and fragmented as to make segregation impracticable, or are too large or too irregular to fit into glass graduates.

Visual estimates of relative proportions of quantity often are used in studying foods of herbivores, large predators, and fish-eating birds. In deer-food studies, it has been found advantageous for two individuals to check their independently-made estimates. Frequently combinations of estimating and measuring are employed. In a crop or stomach, some easily separated items may be segregated and measured while others, occurring in a mixture, may be estimated as to relative proportion of a measured or unmeasured total. Segregating items into distinct piles, or analyses of representative samples of fragmented and mixed materials, will often assist in arriving at satisfactory estimates of proportions.

In upland game bird studies, volume is often measured by use of glass graduates suited to the purpose. In addition to the medium-sized graduates (5 cc, 10 cc, or more) available commercially, smaller "home-made" ones can be constructed to facilitate measurement of small quantities. Irregular objects, between which considerable air space may be present, can be more accurately measured by using lead shot of various sizes or by immersion in liquid to ascertain displacement. All these measuring procedures, however, require time and the investigator must decide whether they appear justified.

Grit, lead shot, and "trap debris," though commonly noted as to presence and quantity, should not be included in the food computations. In a gizzard, for example, the food should total 100 percent exclusive of the grit present.

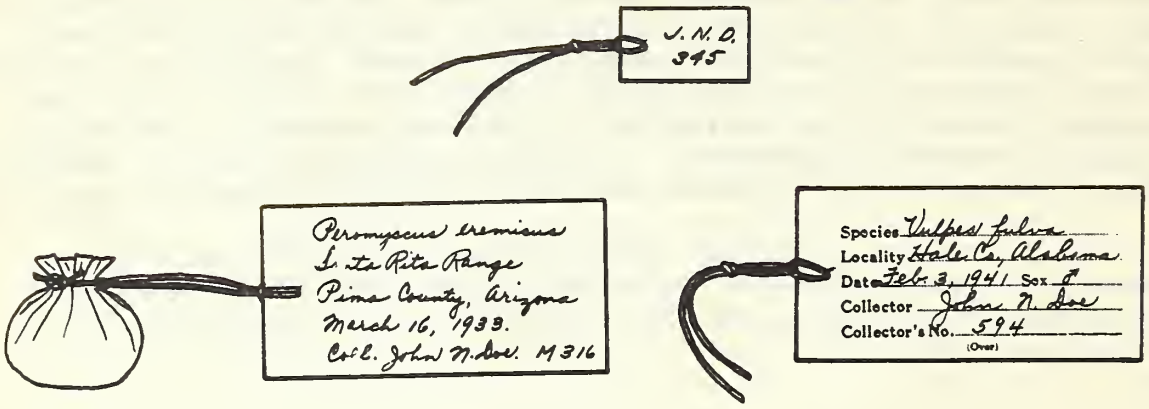

FIGURE 1. -- Three types of identification tags.

Odocoileus virginianus Sex M No. M42909
State North Carolina Co. Pender Loc. Wallace Deer Club
Date 11-16-46 Hr. 10:30 A Collector W. D. Robbins Coll. No. 7
Stom. ____ cc. Crop ____ cc. Anim. ____ % Veg. 100 % Grit ____ cc. ____ %
Examined by John N. Doe Date 3-24-47

Cyrilla racemiflora 85%
Pinus sp. 10%
Ilex sp. 5%

Myrica cerifera
Vaccinium crassifolium
Smilax laurifolia

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FIGURE 2. -- Sample examination card used by the Fish and Wildlife Service.